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Docket No. 125691-2 (13591US02)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application of:	
Boyd, et al.	EXPRESS MAIL NO. EV 729165393 US
Patent No: 7,020,511	DATE: June 13, 2006
Issued: March 28, 2006	
Serial No: 10/064,756	
Filed: August 14, 2002	
For: METHOD FOR THREE DIMENSIONAL CINE EBA/CTA IMAGING	

REQUEST FOR CERTIFICATE OF CORRECTION UNDER 37 CFR §§ 1.322 & 1.323

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Attention: Certificate of Correction Branch

Sir:

Pursuant to 37 CFR §§ 1.322 & 1.323, Applicants hereby request a Certificate of Correction to be issued for the above-identified U.S. Patent, correcting the patent as noted herein and on attached "Certificate of Correction" form PTO 1050 (Rev. 2-93). Duplicate copies of the form PTO 1050 are attached hereto.

At col. 11, line 35, delete "3 eg." and insert --e.g.--

At col. 12, line 11, delete "03 . . . seconds" and insert --0.3 seconds--

At col. 12, line 38, delete "lloriz" and insert --Horiz--

At col. 13, line 45, after "(1:5)" insert -- — --

At col. 13, line 46, delete "17" and insert --r17--.

REMARKS

In accordance with Applicants' request, Applicants' attach hereto two copies of the corresponding form PTO 1050 bearing the requested correction. Also enclosed are columns 11-12 and 13 of US 7,020,511 indicating where the changes should occur.

The Commissioner is hereby authorized to charge Deposit Account No. 07-0845 (GTC) the amount of $100.00 to cover the fee under 37 C.F.R. §1.20(a) or if any other fees are due as a result of filing this paper.

Respectfully submitted,

McANDREWS, HELD & MALLOY, LTD.

Dated: June 13, 2006

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JUN 16 2006

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UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 7,020,511

DATED : March 28, 2006

INVENTOR(S) : Boyd, et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

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At col. 12, line 38, delete "Iloriz" and insert --Horiz--

At col. 13, line 45, after "(1:5)" insert -- – --

At col. 13, line 46, delete "17" and insert --r17--

MAILING ADDRESS OF SENDER:

McAndrews, Held & Malloy, Ltd.
500 West Madison Street, 34th Floor
Chicago, Illinois 60661

Patent No: 7,020,511
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FORM PTO 1050 (Rev. 2-93)

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FORM PTO 1050 (Rev. 2-93)

an arc. The electron beam may sweep in a 360-degree arc with 210-degrees of the 360-degree arc occupied by the target ring 130.

Then, at step 225, as the electron beam impinges upon the tungsten target ring 130, the tungsten material is excited by the electron beam. X-rays or other such radiation are produced from the excitation and travel outward from the target ring 130. The path of the x-rays depends upon the angle at which the electron beam impacted the target ring 130. At step 230, at least some of the x-rays pass through the patient and impinge upon the detector ring 140.

At step 235, the data acquisition system (DAS) 160 receives signals from the detector ring 140 that are indicative of x-rays impacting the detector ring 140. The received data signals vary in value depending upon the angle and intensity of the x-rays striking the detector ring 140. A larger data value indicates an x-ray that is only slightly attenuated along the x-ray's path from the target ring 130 to the detector ring 140. A smaller data value indicates an x-ray that is greatly attenuated by an organ or other dense mass when travelling from the target ring 130 to the detector ring 140. When no data value is received for a certain portion of the detector ring 140, this indicates that the x-rays impacted bone in the patient and are totally blocked. The DAS 160 transmits the image data to other processing units for further processing and display. The DAS 160 may transmit supplemental data as well, such as ECG data, timing information, triggering information, and/or patient information. Alternatively, the DAS 160 may process the image data. The image data from a single sweep forms a complete image frame.

At step 240, the patient may be moved between or during electron beam sweeps. If moved between sweeps, the patient may be moved by the thickness of a slice (e.g. 1.5 millimeters, ~~3 millimeters, 6~~ millimeters, etc.). Alternatively, the patient may be moved continuously during imaging (3 eg. at a rate of 1.5 millimeters, 3 millimeters or 6 millimeters per second). Then, at step 245, after the desired motion has occurred, another sweep may be triggered. For example, after the patient has been moved three millimeters, another electron beam sweep may be triggered at 40% of the next R-to-R interval. The steps described above may be repeated for another sweep. Finally, at step 250, after a desired number of sweeps have been executed and imaging data obtained and processed for a sequence of image frames, the image frames may be displayed as a cine loop. The cine sequence may also be stored or printed. In certain embodiments, the desired number of sweeps are executed in two or more cardiac cycles. The process described above in reference to FIG. 2 may be repeated if desired.

e.g.

FIG. 3 illustrates an ECG-triggered step-cine sequence 300 as used for electron beam angiography in accordance with an embodiment of the present invention. The sequence 300 involves a contrast injection. The sequence 300 uses an ECG-trigger with a 0.3 second R-to-R interval delay. Also, the sequence 300 uses every heartbeat for scanning unless the heart rate rises above a certain speed threshold. Additionally, the sequence 300 uses a 50 millisecond sweep, performing 4 sweeps per level of the heart (equals 8 slices/level with a dual-slice detector ring). The sequence 300 employs a 3.0 millimeter forward table motion between sweeps.

First, the system 100 is prepared for an image scanning sequence. The patient positioner 150 is moved into position. The electron beam is first triggered (Trigger(1)) after a certain point in an R-to-R interval for pre-scan configuration. A pre-scan may be used to configure or calibrate the system 100 and obtain patient position and other such information. Then, a contrast agent is injected into the patient and the system 100 delays to wait for the second trigger (Trigger(2)). After Trigger(2) triggers a second pre-scan, a delay is observed to prepare the system 100 for another pre-scan. Then, Trigger(3) triggers at the start of an R-wave for the third pre-scan. After a 0.3 second delay, four imaging sweeps of the target ring 130 are executed. After the fourth sweep, the patient positioner 150 is moved 3.0 millimeters. The system 100 waits for two heartbeats. Then, the electron beam is triggered at a selected point in an R-wave. After a delay (e.g., 03 . . . seconds), four more sweeps of the target ring 130 are executed.

0.3 seconds

A cine loop may be created from image data obtained during the sweeps of the target ring 130. Image frames are formed from data obtained during a sweep of the target ring 130. The image frames may be displayed individually or displayed in sequence to show cardiac motion. Cine imaging is used to animate the images and create a 2-D or 3-D effect.

FIG. 4 illustrates an example of a sweep map 400, which describes a scanning series in a sweep-by-sweep format in accordance with an embodiment of the present invention. The sweep map 400 is described as follows. The sweep row in the map 400 represents a sweep number from 1 to 8. The sweep number may repeat according to the number of slices and levels chosen. The coll row in the map 400 represents collimation in the system 100. In the map 400, a collimation of 3 indicates the use of dual 1.5 mm slices in scanning. The mA row indicates a desired number of milliamps to drive the electron beam, for example 1000 mA. The characteristic kV indicates a desired kilivoltage for the electron beam, such as 140 kV, for example. The Det parameter in the map 400 represents a number of detector rings 140 in the system 100. A value of 3 in a two detector ring 140 system 100 indicates that both detector rings 1 and 2 are used. Type represents a type of sweep to be executed. In certain embodiments, a value of ~~3 indicates a sweep speed of 50 milliseconds, for~~ example Horiz indicates horizontal position of the patient positioner 150. In the map 400, a value of 400 indicates a 400 millimeter position relative to a user-defined zero position. A value of 397 indicates 397 millimeters, which implies that the patient positioner 150 moved back 3.0 millimeters between triggers. Vert is patient positioner 150 vertical position, such as 210 millimeters, for example. Slew is patient positioner 150 slew, or lateral movement beside the plane of motion. A slew of 0 degrees indicates no slew. Tilt is a tilt of the patient positioner 150, representing movement within the plane of motion. A tilt of 0 degrees indicates no tilt. The row labeled Table Incr lists an increment of patient positioner 150 motion during each sweep. A table increment of 0 at sweep=0 indicates that the table did not move during scanning in sweep 0, for example. Target represents a type of target ring 130. For example, Target=3 indicates a C-ring target.

Horiz

The Trigger row in the map 400 reflects an array indicating trigger type. A trigger type array may be in the form of Trigger=(a,b,c,d), for example. For example, in sweep 1 of the map 400, Trigger=(5,1,7,5,9), wherein 5 equals the total entries into the trigger array; 1 indicates that a manual trigger is to be a first trigger; 7 instructs the system 100 to wait for a bolus injector trigger to be a second trigger; 5 represents the minimum number of beats to skip and directs to choose the first available trigger; and 9 indicates that a timed delay may be used after an R-wave. In sweep 5, Trigger=(4,8,5,9). Thus, there are 4 entries into the array. Array element 8 indicates that table motion is completed before a scan. Array element 5 indicates that the first

available trigger may be chosen. Array element 9 instructs the system **100** to use a timed delay after an R-wave.

The Delay row in the map **400** represents a delay array associated with the trigger array. For example, Delay=(a,b, c,d). In sweep 1 of the map **400**, for example, Delay=(5,0, 16,0,0.3), wherein 5 indicates 5 total entries in the delay array; 0 indicates 0 seconds timed delay after a manual trigger; 16 indicates a timed delay of 16 seconds after a bolus injector trigger; 0 determines that 0 skipped heartbeats is a minimum number to skip based on thermal modeling, sweep times, table step minimum times, and reasonable heart rate, for example; and 0.3 represents a 0.3 second delay after an R-wave to start sweep 1. In sweep 5 of the map **400**, Delay=(4,0.25,0,0.3). A value of 4 indicates 4 entries in the Delay array. A value of 0.25 relates to a 0.25 second minimum patient positioner **150** step time between sweeps. A value of 0 in the third array position indicates a minimum of 0 skipped heartbeats. A value of 0.3 in the last position indicates a 0.3 second delay after an R-wave to start a sweep, for example.

FIGS. **5** and **6** illustrate an EBA scanning series in accordance with certain embodiments of the present invention. In FIGS. **5** and **6**, the electron beam may be turned on after an R-wave has been detected. That is, FIGS. **5** and **6** depict a scan execution in which a delay after an R-wave is less than or equal to the time period for electron beam power up.

FIG. **5** illustrates a time sequence **500** before scan 1 begins, in accordance with certain embodiments of the present invention. In FIG. **5**, a sweep includes activities before the sweep plus a traversal of the target ring **130**. The notation Trigger(1:3) indicates that the trigger for sweep 1 is the third element in the Trigger array. In the time sequence **500**, Trigger(1:3)=7, which indicates a bolus injection, for example. Time stamps are indicated by tn, where n may increment. For example, the first time stamp is t0. R-waves may be shown as R(n,rn), where n may increment as R-waves are collected and rn is a time at which the nth R-wave appeared. In the time sequence **500**, t0 is the clock time at manual trigger. Time stamp **t1** is the clock time at the bolus injector trigger. Time stamp **t2** may be calculated as the t1+Delay(1:3), or t1+16 seconds, for example. In the time sequence **500**, Delay(1.4) is 0 (no skipping), so R-wave R(17,r17) ~~may~~ be used to start scanning. Time stamp t3=r17+Delay(1:5)-timePSon=**r17**+0.3 seconds-0.130 seconds. Time t4-17+Delay(1:5)=r17+0.3 seconds.

r17

In the time sequence **500**, after the first R-wave **R(1,r1)**, the system **100** begins pre-scan configuration and calibration. After a bolus injection of contrast agent at **t1**, the system **100** may wait for the agent to affect the heart and coronary arteries. Then, after R-wave R(**17**,r**17**), the electron beam may be powered on and a series of four sweeps begun on the target ring **130**. The series of sweeps will be illustrated in FIG. **6** below.

FIG. **6** illustrates a time sequence **600** between sweep 1 and sweep 2, in accordance with certain embodiments of the present invention. Assuming the same delay parameters (delay>power on time) are used from the start of sweep 1 to the start of sweep 5, the same timing may be used on each subsequent trigger. In the time sequence **600**, time taken during a sweep is represented as tSn, where n increments with the sweep number. Time intervals tm equal the previous time interval tm-1 plus the time taken during the previous sweep. For example, in the time sequence **600**, the time to start sweep 2 is defined as t5. In time sequence **600**, t5 t4+tS1. Time during a sweep in sequence **600** represents total sweep time, including retrace-on, target time, and retrace-off time, for example. Horizontal table positions may be sent to the patient positioner **150** as they appear in the sweep map **400** and are represented as hn, where n is the sweep number. In time sequence **600**, table position **h1** is the position of the patient positioner **150** during sweep 1 and is equal to 400. Table position **h5** is the patient positioner **150** position during sweep 5 and is equal to 397 (a movement of 3.0 millimeters).

In the time sequence **600**, four sweeps of the target ring **130** are executed over intervals tS1 through tS4, beginning at time stamp **t4**. Image data is obtained from each sweep. At time stamp **t8**, the electron beam is turned off. Additionally, the patient positioner **150** may be moved after sweep **4**. After a certain point in the R-wave R(**18**,**r18**), the electron beam may be powered on again. After a certain delay Delay(5:4), the motion of the patient positioner **150** may cease and the next sequence of target ring **130** sweeps may begin. Additional image frames may be generated from the sweeps to form a cine loop of image frames. The image display and manipulation system **164** may combine the image frames into a cine imaging loop displaying motion of the heart and coronary arteries over time and cardiac phase.

FIGS. **7** and **8** illustrate image scanning sequences in which a delay chosen is less than the time taken to activate the power supply for the electron beam. In FIGS. **7** and **8**, the electron beam is turned on before an upcoming R-wave. That is, FIGS. **7** and **8** depict a scan execution in which a delay after an R-wave is greater than the time period for electron beam power up. If a delay is set less than the electron beam power on time, the high voltage module **124** is turned on in anticipation of the R-wave and delay. If the beam is not turned on early enough or the R-wave comes unexpectedly early, the beam may not be ready to sweep the target ring **130**. If the electron beam is not ready to sweep the target ring **130**, the beam may be deactivated and the start time recalculated for the next expected R-wave. In certain embodiments, the electron beam may be aimed at a beam stop in anticipation of an R-wave. The beam stop may absorb heat from the electron beam up to a thermal capacity based on the material used for the beam stop. If a valid R-wave does not arrive before the thermal capacity of the beam stop is reached, the series may be aborted and calculations restarted.

FIG. **7** illustrates a time sequence **700** for a scan from user confirmation to start of sweep 1 on the target ring **130** in accordance with certain embodiments of the present invention. The time sequence **700** is similar to the time sequence **500**, described above. In the time sequence **700**, however, the dotted line indicates electron beam power-on time. The electron beam may be powered-up by focusing it on a beam stop during the period between t5 and t7, indicated by the dotted line, for example. In the time sequence **700**, PR(17, pr77) indicates a predicted R-wave time, where n represents a number of heartbeats. The PR(17,pr17)time is used to initiate the electron beam. The time R(17,r17) indicates the actual incidence of an R-wave. After the electron beam is powered on and a delay is observed to allow the electron bream to reach a desired intensity, sweep 1 may be triggered at time t7 at a desired point in the R-wave R(**17**,**r17**). If the time between the predicted R-wave PR(**17**,**r17**) and the actual R-wave R(**17**,**r17**) exceeds a certain threshold, the beam stop may reach a thermal limit. If the beam stop's thermal limit is reached, the series of sweeps may be abandoned and restarted.

FIG. **8** illustrates a time sequence **800** from start of sweep 1 on the target ring **130** to start of sweep 5 on the target ring **130** in accordance with certain embodiments of the present